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Hungarian agriculture machinery market: Examining of operating costs of machines

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ABSTRACT

The operating costs of machines constitute a significant proportion of the expenses involved in agricultural production, and thus the appropriate and inappropriate use of machinery can significantly influence the efficiency of farming. This study aims to present the market of agricultural power machines, to examine the operating costs and to analyse the causes of changes in the Hungarian machinery market during the past few years. Our research includes statistical data produced between 2013 and 2018. In Hungary, NAIK annually monitors the farm operating costs. Based on these data we are determining the operating costs for 2020. These costs can be effectively reduced by appropriate measures.

Key words: EU subsidies, Hungarian machinery, machinery costs, power machine, operating costs

INTRODUCTION

At the end of the 20th century, significant changes occurred in the Hungarian agricultural sector (e.g. ownership, structure, laws, machinery etc.) (Csáki, 1998). Today, improving agricultural productivity, while conserving and enhancing biotic and abiotic resources, is an essential requirement to increase sustainable global food production on a sustainable basis. New methods, mechanisms and management practices were developed for agricultural production and real-time resource allocation (Mitter et al., 2016; Moghaddam and Nof, 2016; Xue et al., 2012). According to the study of Strauss (2016), farmers need to keep up with rapid changes. To successfully adapt and actively shape change, i.e. to be resilient, learning is crucial. Over the last century, agriculture transformed from a labour-intensive industry towards mechanisation and power-intensive production systems, while over the last 15 years' is it started being digitised (e.g. precision agriculture, smart technologies, etc.) (Marinoudi et al., 2019). The research of Marchuk and Fabiianska

(2017) also emphasized the importance of the latest technologies in production. Today, most farmers use power machines to help fieldwork, and the agricultural production is very machine intensive. It means that production is difficult without machines and equipment, which are determined by the farmers' knowledge, the parametres of machines, and environmental conditions.

Agricultural machinery includes many types of equipment. Nowadays, in Hungary, many distributors deal with the trading of agricultural machines and spare parts. The most modern and latest models of agricultural equipment are all available for farmers. The portfolio of machines is very diverse and broad, but the agricultural machinery market is very concentrated in Hungary. In 2018, 10 distributors conducted 66% of the total agricultural machinery sales. Out of the total Hungarian machine 49% sales were conducted by the three largest dealers (AKI, 2019).

An important factor of competitive production is mechanization. Mechanization is an important factor of successful economic processes (Némediné Kollár and Neszmélyi, 2015). Good utilization, modernization and timely replacement of machines are important factors of efficient agricultural production. However, how does it work? The decision must be made on the basis of economic calculation. On the one hand, the operating costs of machines form a significant proportion of the expenses involved in agricultural production. The operating costs of agricultural machines are constantly changing; thus, it is important to pay attention to the data. On the other hand, beneficial equipment financing opportunities for farmers increase the purchase of machinery (e.g. machine leasing, machine hire purchase, investment credit for machines).

MATERIAL AND METHODS

In 2013, the Hungarian Central Statistical Office carried out a detailed survey of the number and average age of farm machines in Hungarian agriculture (KSH, 2014). The Research Institute of Agricultural Economics compiles a statistical report on Hungarian agricultural markets every year, which also includes economic data of agricultural machinery and spare parts investment. Our research includes statistical data produced between 2013 and 2018. We emphasize that these data are averages and differences may occur.

Agricultural machinery includes many types of equipment. In our research, the kinds of power machines are as follows: tractors, combines (wheat, maize), self-propelled harvesters, self-propelled loaders, other self-propelled machines. Total operating costs are the sum of the following expenses: oil and lubricants, labour, repair and maintenance, machinery depreciation, other (insurance, equipment storage), fixed as well as current assets, and general costs associated with machines. Our work contains only diesel operated power machines. According to our plan, the diesel oil price is ca. 1.02 EUR/kg, 0.85 EUR/l (tank car) and the average price of lubricants is ca. 2.60 EUR/kg in 2020. Data of agricultural machines based on the data of Hungarian farms.

RESULTS AND DISCUSSION

In 2013, a detailed survey of the numbers and average age of power machines was carried out by the Hungarian Central Statistical Office on Hungarian agriculture. The average age of machines was 18.3 (see Table 1). Most of the machines with a higher kilowatt "size"are 10 years old or younger.

Table 1. Average age of machines (in December 2013)

Agricultural equipment	Average age (years)	Number (piece)
Tractors	19.3	120,887
Combines	15.4	10,770
Other self-propelled machines	15.1	12,346
Total of power machines	18.3	159,610

Source: KSH, 2014

The capacity of engine power per agricultural area is significant, however the number of machines per farm is very low (0.253 piece/per farms). In Hungary, the number of tractors exceeded 100,000 in the early 2000s (Worldbank, 2017).

According to the data of Research Institute of Agricultural Economics, the agricultural machinery market in Hungary is characterized by fluctuation, because one of the most important factors is the availability of EU funding (AKI, 2017). Regions differ in their preferences, and capacity to absorb support through EU funds (Mikuš et al. 2019). Machinery market responds intensively to the financial support opening in machinery purchase, afterwards sales usually fall. This is proved by the increasing number of high engine power tractors per farms (more than 81 engine HP) by 450% between 2000 and 2013, while the numbers of tractors with low engine capacity (less than 26 engine HP) fell by 50% (1 horsepower (HP) = 0.745699872 kW).

The number of agricultural machinery sales in the world market is variable. Total agricultural machinery sales increased between 2010 and 2013, the highest turnover (EUR 103 billion) in the world took place in 2013 (AKI, 2018). At the same time, 2014 was an intensive year in EU agricultural subsidies to Hungarian farmers, so the expansion of the Hungarian machinery market continued until 2014 (more than HUF 160 billion in 2014) (AKI, 2018). The Hungarian machinery market is reacting intensively to the funding subsidies.

In 2017, the sales in the world market started growing and exceeded 100 billion EUR (AKI, 2018). In 2017, precision farming in Hungary became a very important strategy factor, thus the number of sales started growing. This process was also supported by favourable financing opportunities, and by the Hungarian leasing market in the past years. In 2017, 2,958 tractors (40% more than a year earlier) were sold. In 2018, the number of tractor sales increased by 7% (3160 pieces). In the same year, the Hungarian farmers spent 175 billion HUF (15% more than in 2017) on agricultural machines, while more than 49 billion HUF (+11 percent than in 2017) on spare parts. In addition to the sales of new equipment, the market of spare parts has doubled over the last ten years, which may indicate that despite funding and sales, the lifespan of machines has increased (AKI, 2019).

Farmers apparently spent the most on tractors. The proportion of power machines by value was 55% in 2018 (see Figure 1). Within the total sales, tractors accounted for 34 percent, and combine harvesters for 12 percent.

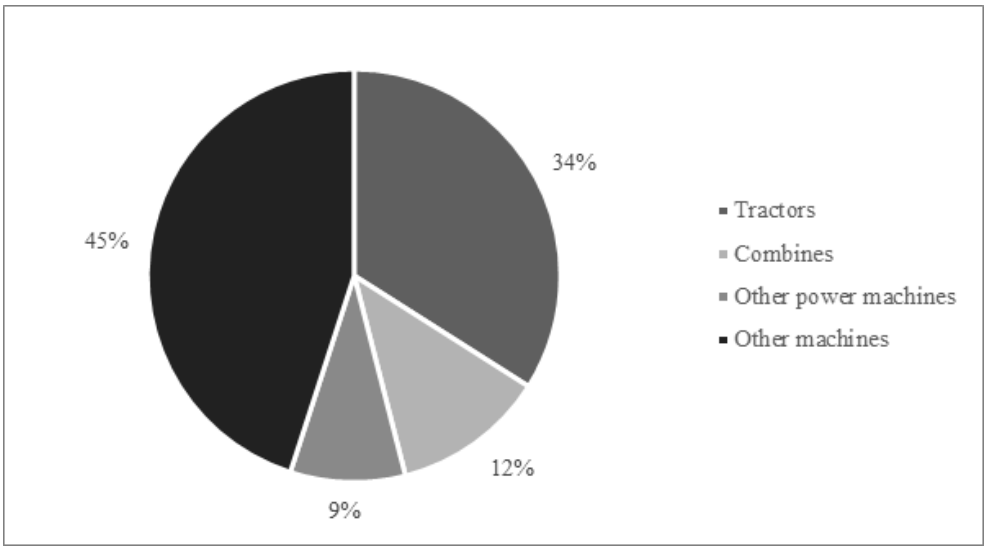

Figure 1. Proportion of power and other machines by value in 2018
Source: AKI, 2019

Demand for more powerful machines has grown rapidly in the market. Machines with an engine power of 37-74 kW were the best-sellers in 2018. In 2018, tractor sales were the highest in the 37-74 kW category with 1,356 pieces (+18 percent) (see Figure 2). A year earlier 1,153 pieces were sold in this engine power category.

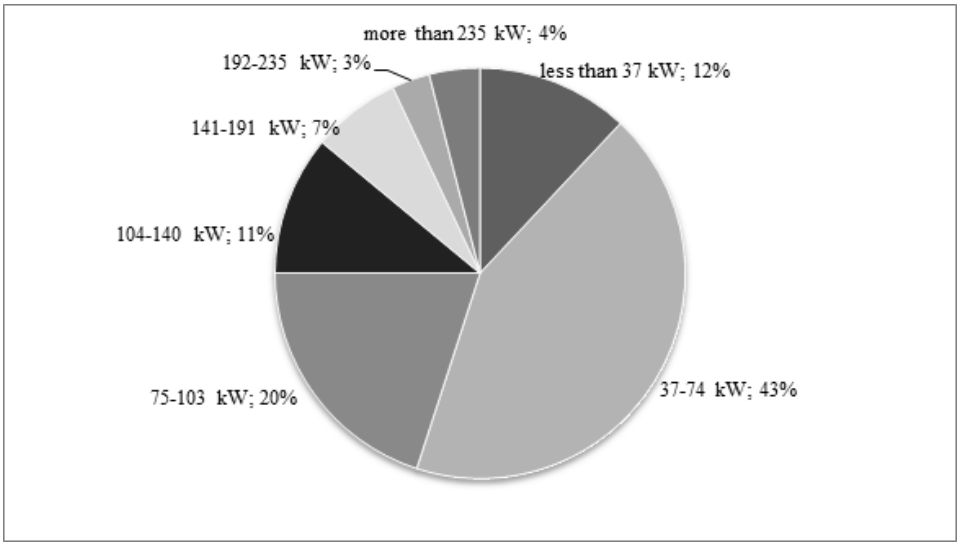

Figure 1. Proportion of tractors in 2018
Source: AKI, 2019

As Table 2 shows, the data of the National Agricultural Research and Innovation Centre (NAIK Hungarian Institute of Agricultural Engineering) are similar to the above data, although the average age of machines is lower than the national average. The average age of power machines is nearly 10 years. In recent years, non-refundable EU subsidies have not been available in the market for producers.

Table 2. Average age of agricultural machines based on data of NAIK (year)

Agricultural equipment	2014	2015	2016	2017	2018
Tractors	11.6	12.4	13.4	11.7	11.9
Combines	2.3	3.0	3.0	7.2	8.8
Self-propelled loaders	16.4	16.0	17.0	11.9	11.2
Other self-propelled machines	5.4	6.5	4.3	3.3	4.8
Total power machines	11.8	12.3	12.0	9.5	9.5

Source: Own calculations

Heinschink et al. (2017) compared simulated crop production costs with actual cost accounting data from farm records in typical Austrian farms. In Hungary, NAIK annually monitors the operating costs based on Hungarian farm data (see Table 3). Operating cost can be 20-30% in annual total production costs (Lips and Burose, 2012). The total operating costs of machines depend on several factors. It is not an easy task for an organization to adapt to environmental changes (Vágány and Kárpátiné Daróczi, 2013). Farms profits can increase if farmers choose to acquire more economically suitable machines. Typically, new equipment operates at low repair and maintenance costs. The skill of the operator, working conditions, and maintenance standards are recognized as important determinants of machinery repair costs, many aspects of which lie within the farmer's control (Morris, 1988).

It is worth noting that a wide variety of power machines and equipment operate, and as such, are used by farmers under different conditions, so the cost can greatly differ. In recent years, the total operating cost of agricultural machines per hectare have been very fluctuating, and the repair and maintenance costs have increased. Due to more advanced machines on the base farms, the ratio of repair and maintenance cost within the total operating cost decreased from 23% to 22%.

Table 3. Machinery costs based on data of "base farms"

	Unit	2015	2016	2017	2018
Engine power per item	kW/piece	109.2	104.2	117.9	120.4
Repair hours per machines per year	h/piece	194	139	148	145
Ratio of repair and maintenance cost of power machines within the total operating cost	%	33	23	23	22
Price of diesel fuel	HUF/kg	283.7	244.3	277.0	351.1
Repair and maintenance costs of machines	HUF/ha	32,960	38,241	40,691	41,646
Operating cost of tractors	HUF/ha	58,383	61,270	68,444	81,837
Operating cost of power machines	HUF/ha	110,014	118,608	111,200	134,809
Price of diesel fuel	EUR/kg	0.88	0.76	0.86	1.06
Repair and maintenance costs of machines	EUR/ha	103	119	126	126
Operating cost of tractors	EUR/ha	182.4	191.4	213.8	247.9
Operating cost of power machines	EUR/ha	347.8	370.5	347.5	408.5

1 EUR=320 HUF (2015-2017), 330 HUF (2018)
Source: Own calculations

It is also important to monitor and reduce operating costs. If farmers do not reduce their operating expenses, they will not be competitive enough in the agricultural sector. A key question, that we consider here, is how we can summarize the actual operating costs of agricultural work performed by different machineries. The presented work outlines the monitored and updated changes concerning agricultural machinery with the use of operational data and values of basic farms in Hungary. We would like to draw attention to our calculated data that helps improve production efficiency, contributes to increased efficiency, improves the quality of work, and reduces costs. Table 4 shows our calculated total operating cost by the main agricultural machine works in Hungary in 2019.

Total operating costs for a particular type of machine varies widely from one geographic region to another because of soil type, rocks, terrain, climate, and other conditions.

Table 4: Total operating cost by the main agricultural machine works in 2019 (without VAT)

No.	Agricultural machine work	Average engine performance [kW]	I. Field category Diesel oil and lubricant cost [EUR/ha]	Repair and maintenance cost	Direct cost	Total operating cost
1.	Plowing up to 20 cm depth	21 - 40 kW	10,7	11,7	45,8	51,6
	Plowing up to 20 cm depth	41 - 75 kW	10,0	9,8	34,1	38,4
	Plowing up to 20 cm depth	76 - 100 kW	9,5	8,4	27,8	31,5
	Plowing up to 20 cm depth	101 - 150 kW	9,0	7,5	24,9	28,2
	Plowing up to 20 cm depth	151 - 200 kW	8,6	6,9	22,0	24,9
2.	Plowing at 21-26 cm depth	21 - 40 kW	15,6	17,0	66,4	74,8
	Plowing at 21-26 cm depth	41 - 75 kW	14,6	14,2	49,4	55,6
	Plowing at 21-26 cm depth	76 - 100 kW	13,7	12,2	40,3	45,6
	Plowing at 21-26 cm depth	101 - 150 kW	13,0	10,9	36,1	40,9
	Plowing at 21-26 cm depth	151 - 200 kW	12,5	10,0	31,9	36,2
	Plowing at 21-26 cm depth	201 - 250 kW	12,0	9,3	29,9	33,8
	Plowing at 21-26 cm depth	251 - 300 kW	11,5	8,9	27,9	31,6
3.	Rolling	21 - 40 kW	3,8	4,0	16,0	18,0
	Rolling	41 - 75 kW	3,5	3,3	11,9	13,4
	Rolling	76 - 100 kW	3,3	2,8	9,7	11,0
	Rolling	101 - 150 kW	3,1	2,5	8,7	9,8
4.	Soil cultivation	21 - 40 kW	4,3	6,5	21,1	23,8
	Soil cultivation	41 - 75 kW	4,0	5,7	16,4	18,5
	Soil cultivation	76 - 100 kW	3,8	5,2	13,9	15,8
	Soil cultivation	101 - 150 kW	3,6	4,8	12,7	14,5
5.	Deep soil loosening	76 - 100 kW	47,3	31,0	127,1	144,2
	Deep soil loosening	101 - 150 kW	44,9	26,6	112,7	127,9
	Deep soil loosening	151 - 200 kW	43,0	23,4	98,1	111,5
	Deep soil loosening	201 - 250 kW	41,2	21,1	91,0	103,3
	Deep soil loosening	251 - 300 kW	39,7	19,7	84,2	95,8
	Deep soil loosening	301 - 350 kW	38,4	18,7	81,9	92,8
	Deep soil loosening	351 - 400 kW	37,3	17,9	76,5	87,0
	Deep soil loosening	401 - 450 kW	36,7	17,4	76,4	86,8
6.	Sowing (grain)	21 - 40 kW	3,5	8,7	23,8	27,3
	Sowing (grain)	41 - 75 kW	3,3	8,1	20,0	23,0
	Sowing (grain)	76 - 100 kW	3,1	7,6	17,9	20,7
	Sowing (grain)	101 - 150 kW	3,0	7,4	17,0	19,6
	Sowing (grain)	151 - 200 kW	2,8	7,1	16,0	18,5
7.	Planting (corn)	21 - 40 kW	4,1	9,7	27,8	32,0
	Planting (corn)	41 - 75 kW	3,8	9,0	23,4	27,0

	Planting (corn)		76 - 100 kW	3,6	8,4	21,0	24,4	
	Planting (corn)		101 - 150 kW	3,4	8,1	19,9	23,2	
8.	Spraying		21 - 40 kW	2,7	4,3	14,3	16,3	
	Spraying		41 - 75 kW	2,5	3,9	11,4	13,0	
	Spraying		76 - 100 kW	2,4	3,5	9,8	11,3	
9.	Spreading		21 - 40 kW	2,7	3,5	12,5	14,1	
	Spreading		41 - 75 kW	2,5	3,0	9,5	10,8	
	Spreading		76 - 100 kW	2,4	2,7	8,0	9,1	
	Spreading		101 - 150 kW	2,2	2,4	7,3	8,3	
10.	Manure spreading		21 - 40 kW	10,7	25,2	73,9	85,3	
	Manure spreading		41 - 75 kW	10,0	23,3	62,2	72,1	
	Manure spreading		76 - 100 kW	9,5	21,9	55,9	65,2	
	Manure spreading		101 - 150 kW	9,0	21,0	53,1	62,0	
11.	Chopping corn silage		41 - 75 kW	29,1	44,1	123,8	140,4	
	Chopping corn silage		76 - 100 kW	27,4	40,1	105,6	120,4	
	Chopping corn silage		101 - 150 kW	26,0	37,6	97,2	111,0	
	Chopping corn silage		151 - 200 kW	25,0	35,7	88,8	101,5	
	Chopping corn silage		201 - 250 kW	23,9	34,3	84,7	96,7	
12.	Baling with small baler (2 t/ha)		21 - 40 kW	4,3	8,9	25,3	28,8	
	Baling with small baler (2 t/ha)		41 - 75 kW	4,0	8,2	20,6	23,5	
	Baling with small baler (2 t/ha)		76 - 100 kW	3,8	7,6	18,1	20,7	
13.	Baling with big baler (4 t/ha)		41 - 75 kW	12,0	24,5	61,8	70,5	
	Baling with big baler (4 t/ha)		76 - 100 kW	11,3	22,8	54,2	62,2	
	Baling with big baler (4 t/ha)		101 - 150 kW	10,8	21,7	50,8	58,3	
	Baling with big baler (4 t/ha)		151 - 200 kW	10,3	21,0	47,3	54,4	
14.	Harvesting (grain) (7 t/ha)	n.c.	101 - 150 kW	25,9	35,1	107,5	124,7	
	Harvesting (grain) (7 t/ha)	n.c.	151 - 200 kW	25,0	30,5	95,9	111,5	
	Harvesting (grain) (7 t/ha)	n.c.	201 - 250 kW	24,4	26,5	87,0	101,3	
	Harvesting (grain) (7 t/ha)	n.c.	251 - 300 kW	23,5	23,6	80,0	93,2	
	Harvesting (grain) (7 t/ha)	n.c.	301 - 350 kW	22,6	21,3	74,3	86,6	
	Harvesting (grain) (7 t/ha)	n.c.	351 - 400 kW	21,9	19,1	69,2	80,8	
	Harvesting (grain) (7 t/ha)	n.c.	401 - 450 kW	21,2	17,8	65,4	76,2	
	Harvesting (grain) (7 t/ha)	s.c.	101 - 150 kW	26,2	42,1	123,7	144,7	
	Harvesting (grain) (7 t/ha)	s.c.	151 - 200 kW	25,2	36,6	110,2	129,3	
	Harvesting (grain) (7 t/ha)	s.c.	201 - 250 kW	24,6	31,8	100,1	117,5	
	Harvesting (grain) (7 t/ha)	s.c.	251 - 300 kW	23,7	28,3	92,1	108,1	
	Harvesting (grain) (7 t/ha)	s.c.	301 - 350 kW	22,8	25,6	85,4	100,5	
	Harvesting (grain) (7 t/ha)	s.c.	351 - 400 kW	22,1	23,0	79,6	93,8	
	Harvesting (grain) (7 t/ha)	s.c.	401 - 450 kW	21,5	21,4	75,2	88,4	

15.	Harvesting (corn) (8 t/ha)	n.c.	101 - 150 kW	18,5	25,1	76,8	89,1
	Harvesting (corn) (8 t/ha)	n.c.	151 - 200 kW	17,9	21,8	68,5	79,6
	Harvesting (corn) (8 t/ha)	n.c.	201 - 250 kW	17,4	18,9	62,2	72,4
	Harvesting (corn) (8 t/ha)	n.c.	251 - 300 kW	16,8	16,9	57,2	66,6
	Harvesting (corn) (8 t/ha)	n.c.	301 - 350 kW	16,2	15,2	53,1	61,9
	Harvesting (corn) (8 t/ha)	n.c.	351 - 400 kW	15,6	13,7	49,4	57,7
	Harvesting (corn) (8 t/ha)	n.c.	401 - 450 kW	15,2	12,7	46,7	54,4
	Harvesting (corn) (8 t/ha)	s.c.	101 - 150 kW	18,7	28,8	86,8	101,6
	Harvesting (corn) (8 t/ha)	s.c.	151 - 200 kW	18,0	25,1	77,4	90,8
	Harvesting (corn) (8 t/ha)	s.c.	201 - 250 kW	17,6	21,8	70,2	82,5
	Harvesting (corn) (8 t/ha)	s.c.	251 - 300 kW	16,9	19,4	64,6	75,9
	Harvesting (corn) (8 t/ha)	s.c.	301 - 350 kW	16,3	17,5	60,0	70,5
	Harvesting (corn) (8 t/ha)	s.c.	351 - 400 kW	15,8	15,7	55,9	65,8
	Harvesting (corn) (8 t/ha)	s.c.	401 - 450 kW	15,3	14,7	52,8	62,0

n.c.: normal condition, s.c.: special condition
1 EUR = 337 HUF
* Multiplication numbers are redundant when instruments measure machine work. According to the law of No. 60/1992. (IV.1.)

Four territorial categories can be distinguished:

- Category I: flat, soft soil. Multiplication number: 1.
- Category II: flat, hard soil, or mild slope, hard soil. Multiplication number: 1.16 (work in soil), 1.12 (work on soil surface).
- Category III: flat, sand, or mild slope, hard soil, or slope, soft soil. Multiplication number: 1.38 (work in soil), 1.24 (work on soil surface).
- Category IV: mild slope, sand, stiff soil, or slope, hard and stiff soils. Multiplication number: 1.72 (work in soil), 1.44 (work on soil surface).

Source: Own calculations

CONCLUSION

Nowadays, agricultural machinery distributors offer more machine types than in previous years. In recent years, the spread of cutting-edge technologies and techniques have accelerated. Producers need to adapt to new market trends, technological developments and weather challenges. The role of farmers to increase sustainable productivity will be crucial. More and more farmers are confronted with the fact that extreme weather changes can lead to very limited agricultural work time. This draws farmers' attention to more powerful and efficient machines, which it also fuelled by the continuing labour shortage in the sector. At the same time, on the one hand, farmers look for modern and innovative machines, while on the other hand, they buy more simple machines with lower investment costs. During the next decade, it will be necessary to develop novel combinations of management strategies to sustainably increase crop production and soil resilience (Schröder et al., 2019).

Precision production has had an impact on increasing machine demand in Hungarian agriculture. Increasing demand for precision farming equipment plays an important role in the expansion of the machinery market. According to experts, the Central Bank of Hungary's Financing Facility for Growth Schedule (NHP Fix), launched in 2019, maintains interest in machine investments. The optimism of agribusinesses is shown by the fact that many farmers are planning to buy machines in the near future. Along with the machinery market, the leasing market has also strengthened. According to the data of the Hungarian Leasing Association, last year saw an increase of 14 percent, so the new agricultural machinery financing was a record with 82 billion HUF (0.2 billion EUR).

In recent years, non-refundable EU subsidies have not been available on the agricultural machinery market, but according to forecasts and other research results, machinery sales will continue to increase in 2020. Data imply that the Hungarian machinery market is characterized by a quantity change, and the demand for new machines depends on the availability of EU and/or national funding.

In recent years, the total operating cost of agricultural machines per hectare has been very fluctuating, and the repair and maintenance costs have increased. The average productivity of Hungarian agriculture has improved, which is due not only to the increase of technical equipment, but also to the improvement of asset efficiency.

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Mađarsko tržište poljoprivrednim strojevima: Istraživanje operativnih troškova strojeva

SAŽETAK

Operativni troškovi strojeva čine značajni udio troškova uključenih u poljoprivrednu proizvodnju i stoga odgovarajuće ili neodgovarajuće korištenje strojeva može značajno utjecati na učinkovitost poljoprivredne proizvodnje. Cilj ove studije je prikazati tržište poljoprivredne mehanizacije, istražiti operativne troškove i analizirati uzroke promjena na mađarskom tržištu poljpoprivrednih strojeva tijekom posljednjih nekoliko godina.. Naše istraživanje uključuje statističke podatke prikupljene između 2013. i 2018. U Mađarskoj, NAIK svake godine prati operativne troškove u poljoprivredi. Na temelju tih podataka utvrđujemo operativne troškove za 2020-u. Ti se troškovi mogu učinkovito reducirati odgovarajućim mjerama.

Ključne riječi: EU potpore, mađarski strojevi, troškovi strojeva, mehanički stroj, operativni troškovi